Nanoscale Characterization of Polymeric Materials and Systems

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In this research program, fundamental measurement science is being developed to study the mechanical properties, optical properties, and related behavior of polymer systems with and without nanoparticles. Because of the effects, both beneficial and detrimental, that nanoparticles can have on material performance, bulk and nanoscale testings are being used to evaluate mechanical and optical properties as a function of dispersion. Dispersion techniques and measurement methods related to the use of nanoparticles in polymeric materials is being developed using a combination of light and neutron scattering metrologies with comparisons to more traditional microscopy measurements. Nanoindentation and atomic force microscopy (AFM) are used as the primary tools for the mechanical property study. Interactions between the probe tip of nanoindentor and sample surface are of interest. Experimental development of the mechanical measurements will be incorporated with modeling (e.g., finite element analysis) and theoretical development aimed at elucidating the viscoelastic nature of polymers at micrometer and nanometer scales. These high-resolution measurement methods are applied to study fundamental problems with broad industrial impact in areas such as the durability of polymeric coatings, the photoreactivity of metal oxide-polymer nanocomposites, interface / interphase characterization in multi-phase, multi-component polymer systems, and the scratch and mar resistance of coatings and plastics.